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RADIOACTIVITY[1]

By the late SIR JOSEPH (JOHN) THOMSON, Master of Trinity College, Cambridge

I NOW pass to a very brief consideration of one of the most important and interesting advances ever made in physics, and in which Canada, as the place of the labors of Professors Rutherford and Soddy, has taken a conspicuous part. I mean the discovery and investigation of radioactivity. Radioactivity was brought to light by the Röntgen rays. One of the many remarkable properties of these rays is to excite phosphorescence in certain substances, including the salts of uranium, when they fall upon them. Since Röntgen rays produce phosphorescence, it occurred to Becquerel to try whether phosphorescence would produce Röntgen rays. He took some uranium salts which had been made to phosphoresce by exposure, not to Röntgen rays but to sunlight, tested them, and found that they gave out rays possessing properties similar to Röntgen rays. Further investigation showed, however, that to get these rays it was not necessary to make the uranium phosphoresce, that the salts were just as active if they had been kept in the dark. It thus appeared that the property was due to the metal and not to the phosphorescence, and that uranium and its compounds possessed the power of giving out rays which, like Röntgen rays, affect a photographic plate, make certain minerals phosphoresce, and make gases through which they pass conductors of electricity.

Niepce de Saint-Victor had observed some years before this discovery that paper soaked in a solution of uranium nitrate affected a photographic plate, but the observation excited but little interest. The ground had

[1] Concluding portion of the address of the president of the British Association for the Advancement of Science, given at Winnipeg in 1909. Reprinted from the issue of SCIENCE for August 27, 1909. Sir Joseph Thomson died on August 30.

not then been prepared, by the discovery of the Röntgen rays, for its reception, and it withered and was soon forgotten.

Shortly after Becquerel's discovery of uranium, Schmidt found that thorium possessed similar properties. Then Monsieur and Madame Curie, after a most difficult and laborious investigation, discovered two new substances, radium and polonium, possessing this property to an enormously greater extent than either thorium or uranium, and this was followed by the discovery of actinium by Debierne. Now the researches of Rutherford and others have led to the discovery of so many new radioactive substances that any attempt at christening seems to have been abandoned, and they are denoted, like policemen, by the letters of the alphabet.

Mr. Campbell has recently found that potassium, though far inferior in this respect to any of the substances I have named, emits an appreciable amount of radiation, the amount depending only on the quantity of potassium, and being the same whatever the source from which the potassium is obtained or whatever the elements with which it may be in combination.

The radiation emitted by these substances is of three types known as α, β and γ rays. The α rays have been shown by Rutherford to be positively electrified atoms of helium, moving with speeds which reach up to about one tenth of the velocity of light. The β rays are negatively electrified corpuscles, moving in some cases with very nearly the velocity of light itself, while the γ rays are unelectrified, and are analogous to the Röntgen rays.

The radioactivity of uranium was shown by Crookes to arise from something mixed with the uranium, and which differed sufficiently in properties from the uranium itself to enable it to be separated by chemical analysis. He took some uranium, and by chemical treatment separated it into two portions, one of which was radioactive and the other not.

Next Becquerel found that if these two portions were kept for several months, the part which was not radioactive to begin with regained radioactivity, while the part which was radioactive to begin with had lost its radioactivity. These effects and many others receive a complete explanation by the theory of radioactive change which we owe to Rutherford and Soddy.

According to this theory, the radioactive elements are not permanent, but are gradually breaking up into elements of lower atomic weight; uranium, for example, is slowly breaking up, one of the products being radium, while radium breaks up into a radioactive gas called radium emanation, the emanation into another radioactive substance, and so on, and that the radiations are a kind of swan's song emitted by the atoms when they pass from one form to another; that, for example, it is when a radium atom breaks up and an atom of the emanation appears that the rays which constitute the radioactivity are produced.

Thus, on this view the atoms of the radioactive elements are not immortal, they perish after a life whose average value ranges from thousands of millions of years in the case of uranium to a second or so in the case of the gaseous emanation from actinium.

When the atoms pass from one state to another they give out large stores of energy, thus their descendants do not inherit the whole of their wealth of stored-up energy, the estate becomes less and less wealthy with each generation; we find, in fact, that the politician, when he imposes death duties, is but imitating a process which has been going on for ages in the case of these radioactive substances.

Many points of interest arise when we consider the rate at which the atoms of radioactive substances disappear. Rutherford has shown that whatever be the age of these atoms, the percentage of atoms which disappear in one second is always the same; another way of putting it is that the expectation of life of an atom is independent of its age—that an atom of radium one thousand years old is just as likely to live for another thousand years as one just sprung into existence.

Now this would be the case if the death of the atom were due to something from outside which struck old and young indiscriminately; in a battle, for example, the chance of being shot is the same for old and young; so that we are inclined at first to look to something coming from outside as the cause why an atom of radium, for example, suddenly changes into an atom of the emanation. But here we are met with the difficulty that no changes in the external conditions that we have as yet been able to produce have had any effect on the life of the atom; as far as we know at present the life of a radium atom is the same at the temperature of a furnace as at that of liquid air—it is not altered by surrounding the radium by thick screens of lead or other dense materials to ward off radiation from outside, and what to my mind is especially significant, it is the same when the radium is in the most concentrated form, when its atoms are exposed to the vigorous bombardment from the rays given off by the neighboring atoms, as when it is in the most dilute solution, when the rays are absorbed by the water which separates one atom from another. This last result seems to me to make it somewhat improbable that we shall be able to split up the atoms of the non-radioactive elements by exposing them to the radiation from radium; if this radiation is unable to affect the unstable radioactive atoms, it is somewhat unlikely that it will be able to affect the much more stable non-radioactive elements.

The evidence we have at present is against a disturbance coming from outside breaking up of the

radioactive atoms, and we must therefore look to some process of decay in the atom itself; but if this is the case, how are we to reconcile it with the fact that the expectation of life of an atom does not diminish as the atom gets older? We can do this if we suppose that the atoms when they are first produced have not all the same strength of constitution, that some are more robust than others, perhaps because they contain more intrinsic energy to begin with, and will therefore have a longer life. Now if when the atoms are first produced there are some which will live for one year, some for ten, some for a thousand, and so on; and if lives of all durations, from nothing to infinity, are present in such proportions that the number of atoms which will live longer than a certain number of years decrease in a constant proportion for each additional year of life, we can easily prove that the expectation of life of an atom will be the same whatever its age may be. On this view the different atoms of a radioactive substance are not, in all respects, identical.

The energy developed by radioactive substances is exceedingly large, one gram of radium developing nearly as much energy as would be produced by burning a ton of coal. This energy is mainly in the α particles, the positively charged helium atoms which are emitted when the change in the atom takes place; if this energy were produced by electrical forces it would indicate that the helium atom had moved through a potential difference of about two million volts on its way out of the atom of radium. The source of this energy is a problem of the deepest interest; if it arises from the repulsion of similarly electrified systems exerting forces varying inversely as the square of the distance, then to get the requisite amount of energy the systems, if their charges were comparable with the charge on the α particle, could not when they start be further apart than the radius of a corpuscle, 10^{-13} cm. If we suppose that the particles do not acquire this energy at the explosion, but that before they are shot out of the radium atom they move in circles inside this atom with the speed with which they emerge, the forces required to prevent particles moving with this velocity from flying off at a tangent are so great that finite charges of electricity could only produce them at distances comparable with the radius of a corpuscle.

One method by which the requisite amount of energy could be obtained is suggested by the view to which I have already alluded—that in the atom we have electrified systems of very different types, one small, the other large; the radius of one type is comparable with 10^{-13} cm., that of the other is about 100,000 times greater. The electrostatic potential energy in the smaller bodies is enormously greater than that in the larger ones; if one of these small bodies were to explode and expand to the size of the larger ones, we should have a liberation of energy large enough to endow an α particle with the energy it possesses. Is it possible that the positive units of electricity were, to begin with, quite as small as the negative, but while in the course of ages most of these have passed from the smaller stage to the larger, there are some small ones still lingering in radioactive substances, and it is the explosion of these which liberates the energy set free during radioactive transformation?

The properties of radium have consequences of enormous importance to the geologist as well as to the physicist or chemist. In fact, the discovery of these properties has entirely altered the aspect of one of the most interesting geological problems, that of the age of the earth. Before the discovery of radium it was supposed that the supplies of heat furnished by chemical changes going on in the earth were quite insignificant, and that there was nothing to replace the heat which flows from the hot interior of the earth to the colder crust. Now when the earth first solidified it only possessed a certain amount of capital in the form of heat, and if it is continually spending this capital and not gaining any fresh heat it is evident that the process can not have been going on for more than a certain number of years, otherwise the earth would be colder than it is. Lord Kelvin in this way estimated the age of the earth to be less than 100 million years. Though the quantity of radium in the earth is an exceedingly small fraction of the mass of the earth, only amounting, according to the determinations of Professors Strutt and Joly, to about five grams in a cube whose side is 100 miles, yet the amount of heat given out by this small quantity of radium is so great that it is more than enough to replace the heat which flows from the inside to the outside of the earth. This, as Rutherford has pointed out, entirely vitiates the previous method of determining the age of the earth. The fact is that the radium gives out so much heat that we do not quite know what to do with it, for if there was as much radium throughout the interior of the earth as there is in its crust, the temperature of the earth would increase much more rapidly than it does as we descend below the earth's surface. Professor Strutt has shown that if radium behaves in the interior of the earth as it does at the surface, rocks similar to those in the earth's crust can not extend to a depth of more than forty-five miles below the surface.

It is remarkable that Professor Milne from the study of earthquake phenomena had previously come to the conclusion that rocks similar to those at the earth's surface only descend a short distance below the surface; he estimates this distance at about thirty miles, and concludes that at a depth greater than this the earth is fairly homogeneous. Though the discovery of radioactivity has taken away one method of calculating the age of the earth it has supplied another.

The gas helium is given out by radioactive bodies,

and since, except in beryls, it is not found in minerals which do not contain radioactive elements, it is probable that all the helium in these minerals has come from these elements. In the case of a mineral containing uranium, the parent of radium in radioactive equilibrium, with radium and its products, helium will be produced at a definite rate. Helium, however, unlike the radioactive elements, is permanent and accumulates in the mineral; hence if we measure the amount of helium in a sample of rock and the amount produced by the sample in one year we can find the length of time the helium has been accumulating, and hence the age of the rock. This method, which is due to Professor Strutt, may lead to determinations not merely of the average age of the crust of the earth, but of the ages of particular rocks and the date at which the various strata were deposited; he has, for example, shown in this way that a specimen of the mineral thorianite must be more than 240 million years old.

The physiological and medical properties of the rays emitted by radium is a field of research in which enough has already been done to justify the hope that it may lead to considerable alleviation of human suffering. It seems quite definitely established that for some diseases, notably rodent ulcer, treatment with these rays has produced remarkable cures; it is imperative, lest we should be passing over a means of saving life and health, that the subject should be investigated in a much more systematic and extensive manner than there has yet been either time or material for. Radium is, however, so costly that few hospitals could afford to undertake pioneerink work of this kind; fortunately, however, through the generosity of Sir Ernest Cassel and Lord Iveagh a Radium Institute, under the patronage of his Majesty the King, has been founded in London for the study of the medical properties of radium, and for the treatment of patients suffering from diseases for which radium is beneficial.

The new discoveries made in physics in the last few years, and the ideas and potentialities suggested by them, have had an effect upon the workers in that subject akin to that produced in literature by the Renaissance. Enthusiasm has been quickened, and there is a hopeful, youthful, perhaps exuberant, spirit abroad which leads men to make with confidence experiments which would have been thought fantastic twenty years ago. It has quite dispelled the pessimistic feeling, not uncommon at that time, that all the interesting things had been discovered, and all that was left was to alter a decimal or two in some physical constant. There never was any justification for this feeling, there never were any signs of an approach to finality in science. The sum of knowledge is at present, at any rate, a diverging not a converging series. As we conquer peak after peak we see in front of us regions full of interest and beauty, but we do not see our goal, we do not see the horizon; in the distance tower still higher peaks, which will yield to those who ascend them still wider prospects, and deepen the feeling, whose truth is emphasized by every advance in science, that "Great are the Works of the Lord."

THE ORIGIN OF THE EARTH'S LAND FORMATIONS

By Dr. C. D. PERRINE

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THE peculiar and very irregular distribution of the land and water areas of the earth's surface as well as their forms and constitutions have attracted attention since man has known of their existence as such. Explanations to account for some of these conditions have been made from time to time, but none has been wholly satisfactory and for some no explanation has been attempted. The object of this note is to put on record the chief points of a general theory which occurred to me some years ago, and which appears to explain satisfactorily a number of observed facts. It is recognized that the difficulties in the way of substantial proofs are very great. For this and other reasons of scientific caution, the hypothesis is presented tentatively for further study and future confirmation or rejection. It is my belief, however, that, in general and radical as it is, it will be confirmed, because some of the evidence is of considerable weight and I have so far found none which is prohibitory.

Several years ago, the principal points known at that time were placed (on a general invitation) at the disposal of a group interested in the progress of science and its dissemination, but as far as I know nothing has yet been published on the subject. These and other details will be given in a full discussion of the hypothesis which it is planned to publish if my impaired health permits.

The theory rests upon the possibility that the earth was bombarded in some past age by a meteoric swarm or swarms which came from a southerly direction. When the explanation first suggested itself, no facts were known which could throw light on this all-important point, the suggestion coming solely from two well-marked peculiarities of continental and mountain

formation, *viz.*, the accumulation of land in the higher northern latitudes with a complementary deficiency in the southern hemisphere, and the appearance of the Indian Peninsula and the Himalayan mountain ranges which give the impression of having been thrust northward into the Asiatic Continent. These suggested a force acting from the south. Later, the fact occurred to me that far the larger number of craters on the moon were in its southern hemisphere.

It is now generally accepted that such "craters" could have been formed by the impact of meteors. If, therefore, these "craters" or a considerable number of them, were formed in that way, the assumption is permissible that the earth may have been, and almost certainly was, bombarded in a similar manner. These circumstances provide the possibility of such meteoric action as could bring about the observed conditions.

Briefly, aside from the above, the principal observed facts and their bearing are as follows:

(1) The large land excess in the northern hemisphere and a corresponding deficiency in the south.

(2) The broadening out toward the equator of the continental areas from their pointed southern extremities and still more in the far northern regions where they form an almost continuous ring about the polar ocean.

(3) An open polar ocean and surrounding land mass in the north, and a continental land mass surrounded by water about the south pole.

(4) Generally greater elevations of the land above sea-level near the southern extremities of the continents than in their northern portions. This is especially noticeable in South America, Africa, Asia and, to some extent, in North America.

(5) Low-lying and frequently marshy or desert areas of great extent in the northern and wider portions of the continental masses.

(6) Carboniferous deposits in these basins, including forests.

(7) As already mentioned, the peculiar appearance of the Indian Peninsula and the Himalaya Mountains to the north. If we look at a contour map of those regions we find the Himalayas folded around the northern and broad part of the Indian Peninsula in just such a manner as is conceivable if the triangular peninsula had been thrust into the Asiatic Continent from the south where we now find the extensive Indian Ocean.

(8) The distances from the South Pole of South America, Africa, India and Greenland all pointed at the southern end, are roughly in the inverse order of their size.

(9) During the Gondwana period the flora (Glossopteris) of India differed greatly from that of Europe but was strikingly similar to the contemporaneous flora of South America, South Africa and Australia.

(10) The southern portions of the South American and African continents are, in general, less temperate than corresponding latitudes in the north.

(11) No secular change in latitude has been established, at least for the continental areas of the northern hemisphere.

(12) Observed earthquake displacements in California, the Philippines and Japan show a relative movement of the continental areas on both sides southward with respect to the Pacific Basin.

(13) It is fairly well established by direct evidence that the earth's crust underneath the great ocean beds is of considerably greater specific gravity than the crust of the continental areas.

(14) The (average) specific gravity of meteorites composing such a swarm may vary from that of stone—say two and one half, to that of iron—say seven.

(15) If, as is usually assumed, the planetary bodies were originally, like the sun, in a gaseous or liquid state, they should remain more or less homogeneous on solidifying, and the present large differences of specific gravity require explanation.

The above are the observed facts for which an explanation is required.

The following hypothesis outlines the course of events and the results which are conceived to have succeeded an encounter of the earth with a swarm or swarms of meteorites. It is assumed that the meteorites came from a southerly direction—not necessarily exactly in the direction of the pole, that they were numerous and that many of them were of considerable size. A single large meteor is not considered capable of having produced the observed effects.

If any considerable part of these meteors was of the heavy metallic type, we have at once a cause for the greater specific gravity of the earth's crust under the oceans. But such an assumption as to specific gravity is not necessary to the general action of such meteor streams because the ordinary stone meteorites are quite sufficient.

Coming from any direction within, say, 30° or 40° of the South Pole, such streams of meteorites could be expected to exert a pressure upon the earth's crust which would depress it where the pressure was normal to the surface, that is, in the regions more or less adjacent to the pole, and elsewhere to "sweep" the surface layers along toward the equator. The known fact that the earth is not perfectly rigid but slightly elastic, and the observed folding of the rock strata are sufficient evidence that such changes can take place. The indications are that these changes have taken place slowly rather than suddenly.

As a further result of such "sweeping" action we can conceive of the land accumulations in the northern hemisphere as formed in a way similar to the snow or sand drifts in the lee of an obstruction, the equatorial bulge acting as such an obstruction.

An alternative, slightly different conception, but one which is simpler and perhaps more probable, is that instead of heavy meteors being responsible for the greater specific gravity of the crust under the oceans, the "sweeping" process has affected only the lighter

layers near the surface, pushing these northward and elevating them above the sea-level, thus exposing heavier layers deeper down. A fact favoring this conception is that the average specific gravity of the entire earth is approximately twice that of the continental masses. It may be that both conceptions are involved.

In a preliminary note it is neither necessary nor feasible to discuss in detail the bearing of the proposed hypothesis on all the different observed peculiarities which have been noted above. In most cases a possible bearing is obvious at a glance, which is enough for the present. That some of these relations are apparent rather than real and that not all will be confirmed, is to be expected. The hypothesis is too radical and too many factors are involved to permit of more than tentative acceptance for careful examination. There appears, however, to be no reason known at present for concluding that some such origin is impossible.

SCIENTIFIC EVENTS

THE BIOLOGICAL RESEARCH INSTITUTE OF THE ZOOLOGICAL SOCIETY OF SAN DIEGO

HOUSED in the hospital and laboratory building of the Zoological Society of San Diego is the Biological Research Institute, whose facilities, research opportunities and two research fellowships have been discussed in a recent number of this journal.[1]

Two out of some thirty applicants have been advised of their election to the two fellowships. Jackson S. Kiser, graduate student at the University of Washington, will pursue at the Biological Research Institute studies of food infection in animals, for work toward the doctor's degree from the University of California at Los Angeles. Lawrence R. Penner, Ph.D., 1940, University of Minnesota, will conduct comparative parasitological investigations. Both these men began their work on September 1.

In addition to the conducting of careful and complete *post-mortem* examinations of all animals which die in the zoo and of many wild animals which are brought in from the outside, dead from natural causes, special hospitalization is given to a great variety of animals maintained in the zoo. Investigations concerning nutritional requirements and especially the parasitic diseases of various animals, are in progress, and an early extension of such studies is planned.

Dr. Charles R. Schroeder, veterinary pathologist in charge of the hospital and laboratory; Dr. Carlton M. Herman, a visiting investigator; and Willis Doetschman, a graduate student in the University of Southern California, are conducting research in various phases of animal parasitology. Dr. Herman's present investigations are concerned with life-cycles of certain worm parasites of seals and other animals. Mr. Doetschman is conducting a survey of internal parasites of captive animals, in partial fulfillment of the requirements for a master's degree. Several voluntary workers and a number of students from San Diego State College on a special National Youth Administration project are carrying out technical and statistical investigations under the direct supervision of Dr. Schroeder.

[1] SCIENCE, 92: 55, 1940.

The Research Committee of the institute, who give their counsel and other assistance without compensation to students and research workers are the following: *Protozoology:* Dr. Rawson J. Pickard, San Diego (chairman); *Pathology:* Dr. Howard A. Ball, San Diego; *Biochemistry:* Dr. Denis L. Fox, assistant professor of marine biochemistry, Scripps Institution of Oceanography of the University of California, La Jolla; *Surgery:* Dr. Hall G. Holder, San Diego; *Ophthalmology:* Dr. George L. Kilgore, San Diego; *Physiology:* Dr. Eaton M. MacKay, director of research, Scripps Metabolic Clinic, La Jolla; *Cardiology:* Dr. Francis M. Smith, Scripps Metabolic Clinic, La Jolla; *Dental Pathology:* Dr. Quintin M. Stephen-Hassard, La Jolla; *Microbiology:* Dr. Claude E. ZoBell, assistant professor of marine microbiology, Scripps Institution of Oceanography of the University of California, La Jolla.

The committee appointed to supervise the research conducted under the fellowships consists of the following members of the Research Committee: Drs. Pickard (chairman), Ball, Fox and ZoBell.

DENIS L. FOX

THE GREAT SMOKY MOUNTAINS NATIONAL PARK

THE Great Smoky Mountains National Park was dedicated at Newfound Gap by President Roosevelt on September 2.

The park is almost equally in the states of North Carolina and Tennessee, on the crest of the Great Smokies. Newfound Gap is on the boundary line, where the park's one trans-mountain road crosses.

Harold L. Ickes, Secretary of the Interior, presided at the dedication exercises, and Governor Clyde R. Hoey, of North Carolina, and Governor Prentice Cooper, of Tennessee, made brief addresses. These were followed by the dedicatory address of the President.

The Great Smoky Mountains National Park is one of the units of the Federal Park System administered by the National Park Service "for the benefit and enjoyment of the people." It may be visited any day

in the year. During 1939, 760,000 persons entered the park to motor over the modern highways or to travel afoot or on horseback over the 500 miles of trails.

Authority for establishment of the park was contained in the act of Congress approved May 22, 1926. In 1930 it was established, in a limited way, for protection and administration only, in accordance with Congressional approval of such limited park status upon the acquisition by the government (by donation) of 150,000 acres of land.

Most of the funds to purchase the lands within the approved boundaries were secured by donation. Contributions of citizens of North Carolina and Tennessee and appropriations by the legislatures of those two states raised approximately half the estimated cost of acquiring the required lands. John D. Rockefeller, Jr., through the Laura Spelman Rockefeller Memorial, offered to match contributions up to $5,000,000, in memory of his mother. Because of bank failures during the depression, which wiped out some donations, and of the inability of many to redeem their pledges through the same cause, and also because of rising land values, difficulty was met in securing all the land necessary to establish the park. President Roosevelt in 1933 allotted $1,500,000 of emergency funds, and Congress appropriated $743,265.20 to acquire the last remaining lands.

A short time ago a Founders Memorial Plaque, with the following inscription, was erected at Newfound Gap in the heart of the park:

For the permanent enjoyment of the people this park was given one half by the people and states of North Carolina and Tennessee and by the United States of America and one half in memory of Laura Spelman Rockefeller by the Laura Spelman Rockefeller Memorial founded by her husband, John D. Rockefeller.

THE MARINE BIOLOGICAL LABORATORY AT WOODS HOLE

AN article in *The Collecting Net* gives an account of the annual meeting of the Corporation and Trustees of the Marine Biological Laboratory, by Dr. Charles Packard, director of the laboratory. At this meeting twelve new members of the corporation were elected as follows:

Dr. H. G. Albaum, Brooklyn College; Dr. C. A. Angerer, Ohio State University; Dr. F. A. Brown, Northwestern University; Dr. Leon Churney, University of Pennsylvania; Dr. G. Failla, Memorial Hospital, New York; the Reverend J. A. Frisch, Canisius College; Dr. F. A. Hartman, Ohio State University; Dr. Marie Hinrichs, Illinois Southern State Teachers' College; Columbus O'D. Iselin, Harvard University, Rockefeller Institute; Mrs. Rebecca Lancefield, Rockefeller Institute; Dr. Floyd Moser, University of Pennsylvania, and Dr. Eric Wald, Harvard University.

Trustees elected by the corporation were:

Dugald E. S. Brown, New York University; H. B. Bigelow, Harvard University; R. Chambers, New York University; W. E. Garrey, Vanderbilt University; S. O. Mast, the Johns Hopkins University; A. P. Mathews, University of Cincinnati; C. W. Metz, University of Pennsylvania; H. H. Plough, Amherst College; W. R. Taylor, University of Michigan.

Drs. Caswell Grave, R. G. Harrison and C. E. McClung, trustees who have reached the age of seventy years, were elected trustees emeriti.

Memorials to the following members of the corporation who have died were read:

Dr. H. McE. Knower, for many years librarian of the laboratory (read by R. G. Harrison).

Dr. M. M. Metcalf, trustee since 1897 (read by R. A. Budington).

Dr. Charles Zeleny, well remembered by the older investigators (prepared by F. Payne).

Captain John Veeder, for fifty years connected with the laboratory, in charge of the boats until his retirement (read by F. R. Lillie).

Discussion at both the meeting of the trustees and of the members of the corporation centered about the new addition to the library, now actually under construction. Dr. Packard states that the necessary funds for its erection have been given by the Rockefeller Foundation, which some years ago aided in the construction of the Brick Building. The new structure, 59×51 feet in outside dimensions, will have the same height and architectural style as the present building. The four tiers of stacks, corresponding to the present stack floors, will provide space for almost twice as many volumes as there are on hand at present. On all floors reading tables will be provided. On the upper two floors there will be a generous amount of space between the tables and the stacks, so that readers should not be disturbed by those who are moving about in the stacks. A part of the basement will be used for the sterilization of glassware, distillation of water and other services requiring steam. Two dark rooms are also provided.

THE DETROIT MEETING OF THE AMER- AT WOODS HOLE

As has already been reported in SCIENCE, sessions of the American Chemical Society will open at Detroit on September 9 and will last through the week.

At two o'clock on Monday the first general session will be held in the Scottish Rite Cathedral of the Masonic Temple. The program will include the presentation of the Women's Award to Dr. Mary Engle Pennington and the presentation of the American Chemical Society Award in Pure Chemistry to Lawrence Olin Brockway. Dr. M. L. Crossley, of the American Cyanamid Company, will make an ad-

dress at this session on "Certain Aspects of the Chemistry of Infectious Diseases" and Dr. Per K. Frolich, of the Standard Oil Development Company, an address on "Butyl Rubber—a New Hydrocarbon Product." The last address on the program is the presidential address of Dr. S. C. Lind, dean of the Institute of Technology of the University of Minnesota, who had taken as his subject "Chemistry within the Atom."

The session will be followed by a tea, and at nine o'clock there will be a reception and dance at the Masonic Temple.

Dr. Charles F. Kettering, vice-president of the General Motors Corporation, who is honorary chairman of the local committee, will give the address at a subscription dinner on Wednesday evening at seven o'clock. At ten o'clock on the same evening there will be a complimentary dance in the ballroom of the Hotel Statler.

Technical sessions of the various divisions of the society are planned for each day. There have been arranged numerous group luncheons, dinners and a large number of excursions to the industrial plants of the city, especially those illustrative of the major phases of automobile manufacture.

The University of Michigan will act as host for an all-day trip. The party will divide according to interests to inspect the following laboratories:

PHYSICAL CHEMISTRY, PHYSICS. Surface chemistry, adsorption, interfacial tension, adhesion tension, radioactivity, counters, electroscopes, refractivity, crystal models, electron diffraction, heats of combustion, the cyclotron, mechanism of electrode potentials and overvoltage.

ORGANIC CHEMISTRY, BIOLOGICAL CHEMISTRY, PHARMACEUTICAL CHEMISTRY. Hormone products, carcinogenic materials, local anesthetics, hypnotics, mydriatics, antispasmodics, absorption spectra, clinical investigation, dental caries, blood diseases, arthritis.

ANALYTICAL CHEMISTRY, INORGANIC CHEMISTRY. Spectrographic methods of analysis, food and drug analysis, titanium precipitates, urea precipitates, tetraphenylarsonium compounds, mineralogical museum.

EXTRACHEMICAL. Burton Memorial Tower, Horace Rackham School of Graduate Studies, Lawyers' Club, Michigan Union, the new Health Service.

CHEMICAL AND METALLURGICAL ENGINEERING, GENERAL LABORATORY. Fluid flow, heat transfer, evaporation and crystallization.

GAS, FUELS AND PETROLEUM LABORATORIES. Analysis, calorimetry, equilibrium cells, columns and pilot plant for equilibrium studies.

METALLURGICAL LABORATORY. Stress-rupture units, creep, vacuum gas analysis apparatus, high-temperature tensile and impact machines.

MICHIGAN STATE HIGHWAY TESTING LABORATORIES. Physical and mechanical testing of road-building materials.

RECENT DEATHS

DR. RAYMOND SMITH DUGAN, professor of astronomy at Princeton University, died on August 31. He was sixty-two years old.

DR. LESTER P. BRECKENRIDGE, professor emeritus of mechanical engineering of the Sheffield Scientific School, Yale University, died on August 22 at the age of eighty-two years.

DR. EDWARD MARTIN KINDLE, chief of the Division of Paleontology of the Geological Survey of Canada, died on August 29 at the age of seventy-two years.

COLONEL THOMAS L. RHOADS, Medical Corps, U. S. A., retired, chief surgeon of the First Army of the American Expeditionary Forces during the world war, died on August 20. He was seventy years old.

HENRY HUDSON NICHOLSON, professor of chemistry and director of the chemical laboratory of the University of Nebraska from 1882 to 1905 and later a consulting engineer, died on August 17 at the age of ninety-five years.

LOUIS AGASSIZ SHAW, assistant professor of physiology in the School of Public Health of Harvard University, died on August 27 at the age of fifty-four years.

DR. HAROLD DOUGLAS SINGER, professor of psychiatry at the College of Medicine in Chicago of the University of Illinois, died on August 28 at the age of sixty-five years.

DR. ERNEST H. LINDLEY, chancellor emeritus of the University of Kansas, professor of psychology from 1898 to 1917, died on August 21 aboard the Japanese liner *Asama Maru*. He was seventy-one years old.

MRS. MARY VAUX WALCOTT, wife of the late Dr. Charles D. Walcott, formerly secretary of the Smithsonian Institution, in which she was research associate, died on August 22. She was eighty years old.

THE death is announced of Dr. Hugo Merton, formerly of Heidelberg, who had been working in the Crew Institute of the University of Edinburgh.

SIR JOSEPH (JOHN) THOMSON, Cavendish professor of experimental physics at the University of Cambridge from 1884 to 1918, when he became master of Trinity College, died on August 30 in his eighty-fourth year.

SCIENTIFIC NOTES AND NEWS

IN recognition of "distinguished service in the hospital field" the American Hospital Association will present its 1940 Award of Merit to Dr. Sigismund S. Goldwater, commissioner of hospitals of New York City, at the annual convention to be held in Boston during the week of September 16.

THE poultry building of the College of Agriculture and Experiment Station of Cornell University was dedicated in June and formally named Rice Hall. *The Experiment Station Record* points out that this is the first college building in the country to be named in honor of a poultryman. It writes: "During his thirty years of work at the university as head of the department, Emeritus Professor James E. Rice molded the thought and activity of many engaged in the industry. He was an eminent teacher and contributed much toward the development of poultry research." The speakers at the dedication included President Edmund E. Day, of Cornell University; Dr. Carl E. Ladd, dean of the New York State Colleges of Agriculture and Home Economics and director of the experiment station; Dr. Liberty Hyde Bailey, formerly dean of the College of Agriculture; representatives of leading poultry interests, and Professor Rice.

O. L. BEISWINGER, of Akron, was elected president of the National Association of Power Engineers at the annual convention at Columbus, Ohio. Stephen C. Castell, of Davenport, Iowa, was elected vice-president.

DR. WILLIAM E. AYLING, of Syracuse, N. Y., was elected president of the New York State Association of School Physicians at the recent annual conference held at Saratoga Springs.

DR. ISAAC H. JONES, of Los Angeles, was elected president of the Pacific Coast Oto-Ophthalmological Society at the recent meeting in Spokane.

JOHN FULTON, after serving for forty-three years in the Oregon State College at Corvallis, since 1907 as head of the department of chemistry, has retired to part-time service as professor emeritus. Dr. E. C. Gilbert, since 1930 professor of chemistry, has been appointed acting chairman of the department.

DR. OSWALD N. ANDERSEN, assistant superintendent of Barnes Hospital, St. Louis, has been appointed general director of the School of Hygiene and Physical Education at Stanford University with the rank of associate professor.

DR. ELWOOD C. DAVIS, who has been in charge of professional preparation and research in physical education at Pennsylvania State College, has been appointed head of the department of physical education at the University of Pittsburgh. He succeeds Dr. John Dambach, who resigned last year to become head of the same department at Queens College, New York.

DR. ROBERT L. MCMURRAY, assistant professor of pharmacy at the Ohio State University, has been appointed associate professor of pharmacy at Washington State College.

DR. JOHN B. LUCKE, associate professor of geology, will become head of the department of geography at the University of Connecticut. He succeeds Dr. Richard E. Dodge, who retired a year ago and is now professor emeritus.

DR. TIMOTHY P. WHITE, who recently retired from the Bureau of Animal Industry, has been appointed professor of anatomy and histology in the School of Veterinary Medicine of Middlesex University, Waltham, Mass.

CHARLES W. COTTERMAN, instructor in genetics and biometry at the Ohio State University, has become a research associate in the laboratory of vertebrate genetics at the University of Michigan. He will conduct studies in human heredity for which funds have been provided by the Board of Governors of the Horace H. Rackham School of Graduate Studies.

BORIS A. KRUKOFF, who has been associated with the New York Botanical Garden while working on his collections of South American plants, has been appointed honorary curator of economic botany.

Current News of Chemistry and Chemical Engineering reports that Harold A. Frediani, until recently instructor in charge of analytical industrial chemistry at the Louisiana State University, has been appointed assistant director of the Fisher Scientific Company Development Laboratory, Pittsburgh, Pa.

The Journal of Chemical Education, edited for the division of education of the American Chemical Society by Professor Norris W. Rakestraw, of Brown University, has formed a group of associate editors. They are: Hubert N. Alyea, Princeton University; Tenney L. Davis, Massachusetts Institute of Technology; Ed. F. Degering, Purdue University; William A. Felsing, the University of Texas; Malcolm M. Haring, the University of Maryland; Philip A. Leighton, Stanford University; Laurence L. Quill, the Ohio State University, and Elbert C. Weaver, Bulkeley High School, Hartford, Conn.

DR. H. A. GLEASON returned to the New York Botanical Garden on August 10 after a two-months' collecting trip in the eastern and middle western states, bringing back 3,000 specimens for the herbarium. Accompanied by John Dwyer, a graduate student from Fordham University, he covered territory from New York to Virginia, west to the Mississippi and Missouri Rivers and north to Minnesota and the Great Lakes region.

DR. A. J. RIKER, professor of plant pathology at the University of Wisconsin, and Dr. P. W. Zimmerman, of the Boyce Thompson Institute, members of a committee for the study of cancer problems and overgrowths in plants, visited the New York Botanical

Garden on August 13 to consult with Dr. B. O. Dodge and members of the laboratory staff of the garden on further activities of the committee.

PROFESSOR ROY S. SWINTON, on leave of absence from the University of Michigan, will join the faculty of the University of the Philippines in Manila, P. I., for a year. Professor Swinton, who was at the University of the Philippines from 1911 to 1913, will advise the university on the installation of a new mechanics and hydraulics laboratory.

THE tenth International Congress of Dermatology and Syphilology will be held in New York City in September under the presidency of Dr. Oliver S. Ormsby. Dr. Paul A. O'Leary, of the Mayo Clinic, Rochester, Minn., is executive secretary.

THE twenty-third annual meeting of the American Society of Ichthyologists and Herpetologists was held in Toronto from September 2 to 4. Sessions were held at the Royal Ontario Museum of Zoology. There was an "open house" in the Biological Building of the University of Toronto on Monday evening. The annual dinner was held in Hart House. On the last day of the meeting there were joint sessions with the American Fisheries Society.

THE National Advisory Cancer Council at a meeting on June 25 at the National Cancer Institute in Bethesda, Md., awarded grants for research on cancer: Washington University School of Medicine, St. Louis, $16,000; Memorial Hospital for the Treatment of Cancer and Allied Diseases, New York, $3,300; Barnard Free Skin and Cancer Hospital, St. Louis, $5,000; University of California Medical School, San Francisco, $5,000, and American College of Surgeons, Chicago, $5,900. Among reports presented at the meeting was a special one on protection of personnel working in cancer clinics against injury from exposure to radium, x-rays and neutrons, by Carl Voegtlin, chief of the cancer institute.

THE Newark Museum has received from Louis Bamberger, of South Orange, a gift of new exhibits and study equipment for the science department. The new material, most of which will be specially designed and made to order, will be ready for installation later this autumn, according to Miss Beatrice Winser, director of the museum. Mr. Bamberger is vice-president of the Board of Trustees. Among the exhibits and equipment acquired through the Bamberger gift are an electrically operated model of the solar system on which the planets move in related speed to one another, a fluorescent mineral room where ultra-violet lamps bring out hidden qualities and colors in minerals; a model of a drop of pond water magnified two hundred and fifty times to show microscopic plant and animal forms, two microscopes and a microprojector together with a number of slides; a series of working models illustrating the structure of the human body, and an "illusion exhibit machine" which performs such miracles as apparently reducing a duck to its skeleton or changing a weasel from summer brown to winter white. The new material will be installed as received and a formal opening of the science department with an entirely new set-up will be held later in the autumn.

COMMANDER F. W. REICHELDERFER, of the U. S. Weather Bureau, has made a statement to the effect that only three institutions in the country now have an advanced meteorological course, and these have each graduated from ten to twenty men a year. Most of the men have been Army and Navy officers sent there by the military service. There have been only about ten to twenty men each year for civilian occupations. This is due to the fact that the opportunity for employment has been limited. However, he states that the new five-day weather forecasting system, initiated recently by the Weather Bureau, is creating a demand for meteorologists.

AN Associated Press dispatch states that construction of a $1,250,000 addition to the plant of the Spencer Lens Company, Buffalo, N. Y., to provide facilities for national defense production, started on September 3. Burton H. Witherspoon, president of the company, states that production facilities have been increased about 50 per cent. and employment has been raised from 1,000 workers to 1,600.

Nature states that Dr. Charles Slater, consulting bacteriologist to St. George's Hospital, London, who died on March 15, bequeathed £10,000 to St. George's Hospital for teaching bacteriology or research work in that science, £5,000 to the University of Manchester for the equipment and maintenance of the laboratories and £4,000 to the University of Cambridge for teaching or research work in medical science.

DISCUSSION

THE FIRST THOUSAND MATHEMATICAL WORKS PRINTED IN AMERICA

THE University of Michigan recently published a volume (xxvi + 697 pp.) entitled "Bibliography of Mathematical Works Printed in America through 1850," edited by Louis C. Karpinski, with the cooperation for Washington libraries of Walter F. Shenton. This book is especially useful to librarians, but it is also of interest to students of the early development of mathematics in the Americas. In fact, on

page xi it is stated that "these illustrations constitute a pictorial history of American mathematics through 1850 on a scale that has not before been attempted with any similar group of American imprints." While mathematical history and mathematical bibliography have much in common their fundamental objectives usually differ widely, and the present work is a bibliography as its title clearly indicates.

A difference between the objectives of a mathematical history and a mathematical bibliography was stated emphatically by the well-known former writer on the history of mathematics, Moritz Cantor (1829–1920), at the International Congress of Mathematicians held at Paris, France, in 1900 and reported in the *Bulletin of the American Mathematics Society,* volume 7, by Charlotte A. Scott (1858–1931), then at Bryn Mawr College. In passing over many minor writers on the subject he remarked "tous aussi morts que leurs livres; gardons—nous de les ressusciter." Probably most historians of mathematics would not be in full accord with this dictum, notwithstanding the great reputation of its author. On account of the vastness of the material with which the modern mathematical historian has to deal it frequently becomes necessary to confine the attention at first to what appears to be most important, and in doing this the first thousand mathematical works printed in America would usually not receive much attention.

While the work under consideration lists only about one thousand different publications without counting different editions of the same work, when these are counted the number of the listed publications is nearly three thousand. As might be expected most of them are text-books which were usually based on more extensive and in most cases better foreign publications. It is interesting to note that the early Spanish publications usually deviated more from their source material than those which appeared in the English language. The earliest work noted is the "Sumario" by Juan Diez Freyle, which was printed in Mexico in 1556 but is much inferior to the well-known "Ars Magna" published by the Italian mathematician, H. Cardan, about eleven years earlier. Various other earlier European mathematical publications are also superior to this earliest known mathematical work printed in America.

In an appendix the author deviates from the title of the work under consideration by treating briefly native American mathematical developments (pp. 607–611). These native developments are much inferior to those made by the Babylonians more than three thousand years before Columbus discovered America. In particular, the Babylonians solved at that early date certain quadratic equations in the sense that they found at least one root of such an equation by methods which are still being used by our high-school students. Much has been written about the ancient Mayan and the ancient Peruvian mathematics, but most of this relates to their methods of representing numbers and exhibits very little mathematical insight in comparison with much older developments in Babylon and in Egypt.

While this volume revives many authors who were as dead as their books it will doubtless be welcomed by the librarians and also by many others who are interested in the early development of mathematics in our country even if the destruction of all these books would not diminish materially our mathematical knowledge. Many will find pleasure in verifying for themselves the lack of originality in the material of nearly all these works and will thus be more impressed by the very slow growth of our modern mathematical knowledge. The abstract form of this knowledge has become so widely useful in our age as a result of the great scientific advances which have demanded continually greater brevity in our statements as regards exact situations.

G. A. MILLER

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PRACTICAL SUGGESTIONS FOR REDUCING THE LABOR OF INDEXING A TEXT-BOOK

INDEXING is an individualistic task which varies with the type of book concerned. While there are no fixed rules, the general principles outlined in this article may be found of assistance to medical and other authors who wish to index their own texts.

Indexing technique must be flexible and allow expansion and rearrangement of entries in order to allow re-use of original drafts of entries when preparing the index of a revised edition. Since each entry must be separable, either individual slips of paper or file cards are customarily used for each entry. The use of letter size sheets of paper each ruled horizontally into four sections—one section for each entry—reduces the number of insertions required in typing.

The selection of subjects and of index entry words requires judgment based on knowledge of the subject, and is improved by some knowledge of indexing. Words which are to be used as leading words of index entries should first be checked *by the author* on the printer's page proof of the text. When the desired leading word does not occcur in the text, it should be written in the margin of the page proof at the proper place.

In deciding upon subjects to be indexed and wording of entries, the author must take into consideration whether the book and index are for the general reader or for the expert. He must also decide whether to

make descriptive entries or whether to compile simply a skeleton type index. The subject of the text itself should not be used as an index entry heading. Capitals should be used sparingly. The page number should be preceded by a comma and should follow the last word of each entry without intervening spaces.

After entry words have been checked by the author on the page proof of the text, an assistant may complete the task of indexing.

Subheadings in a group of entries having the same entry word must be arranged alphabetically. It is difficult to alphabetize subheadings which inadequately describe the entry word. When impossible to alphabetize such subheadings, they may be arranged in progressive order of page numbers.

The complete entries drafted from the entry words checked on the printer's page proof of the text are typed in consecutive order on the quarter-ruled letter size sheets. Each sheet of four entry slips should be numbered consecutively in the upper right-hand corner. A carbon copy of each sheet is preserved intact in original consecutive order. These carbon copies obviate the necessity for rearrangement of the original entry slips from alphabetic back into consecutive order in making a revised edition of the text and index.

On a photographer's cutting board several quarter-ruled sheets at a time are cut into their four separate slips each bearing a single entry.

The cut slips are then sorted into alphabetic order, first according to the leading letter and later according to the second and third letters of the first word of each entry. Alphabetic arrangement is based only on the leading word of each entry. The word which follows the leading word does not form an entity with the latter for purposes of alphabetizing. A compound word is, however, treated as an entity.

The individual slips are then edited and revised. Whenever several entry slips bear identical entries, the page numbers of these are entered in consecutive order upon a single entry slip and the superfluous original slips discarded. Groups of entries having the same entry word are then arranged alphabetically in indented setting, eliminating repetition of their entry word. Cross references are made on blank entry slips and inserted wherever necessary. Errors in alphabetizing are then corrected.

Individual entry slips, arranged in the order in which they are to appear in the index, may be numbered consecutively in the upper left-hand corner of each and sent in slip form to the printer. It is not necessary that they first be pasted upon sheets of paper in their consecutive order, or that they be typed again into a regular manuscript of the index.

Each entry in the printer's galley proof of the index must be checked against the page proof of the text. There is no short cut or substitute for this final recheck.

Index page proof should first be read through for verification of alphabetical order of entries. On the original entry slips ditto marks were used for groups of entries having the same entry word. A second reading is necessary to make sure that none of these ditto marks have been retained as column headings in the page proof of the index. When division of such groups is carried over from one column to the next, the entry word (without page number) should be repeated at the head of the new column.

Insertions in the text of revised editions will render incorrect the page numbers of many of the subsequent index entries. The carbon copies of each sheet of four entries preserved intact in original consecutive order of page numbers are compared with the page proof of the revised text. Where necessary, new page numbers are then assigned to the previously drafted entries. From this point on, the indexing of the revised edition is similar to that of the original.

The method described in this article makes re-drafting the bulk of the index entries in a revision of the index unnecessary. It also avoids the necessity of taking all the previously alphabetized entry slips out of alphabetic order and rearranging into their original consecutive order to permit these drafted entries to be used again in the index of the revised edition of the text.

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THE INCIDENCE OF HYDROGEN SULFIDE AT KILAUEA SOLFATARA PRECEDING THE 1940 MAUNA LOA VOLCANIC ACTIVITY

PERIODIC analyses of the solfataric gases at Kilauea have been carried out by the writers over a period of two years, with the purpose of determining whether there is a correlation between the constitution of these gases and volcanic activity in Kilauea. Since the lavas of this volcano and of near-by Mauna Loa volcano are known to have the same origin, it was felt that there might also be found a relationship to periods of Mauna Loa activity.

Aside from steam, which is the predominant gas, Kilauea solfataric gases were found to be composed of 85 to 98 per cent. carbon dioxide, 1 to 15 per cent. sulfur dioxide and approximately 1 per cent. air. There have been irregular variations in the sulfur dioxide-carbon dioxide ratio during the two-year period, and no eruption of either volcano has occurred.

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No other gases were present in detectable quantities until just prior to the present Mauna Loa activity.

In the collection of March 14, 1940, however, hydrogen sulfide appeared for the first time. It was easily detected qualitatively by odor, by the darkening of lead acetate paper and by the formation of yellow cadmium sulfide when the gas was passed into cadmium sulfate solution. There was not sufficient hydrogen sulfide to make its quantitative determination possible.

On April 7, 1940, volcanic activity broke out at the summit of Mauna Loa. Samples of solfataric gas collected at Kilauea on April 11 again showed the presence of hydrogen sulfide, and samples collected on April 21 likewise contained hydrogen sulfide. The collections of May 10 and June 18 showed no hydrogen sulfide, even though Mauna Loa was still erupting, although with greatly lessened activity.

The appearance of hydrogen sulfide in the Kilauea solfataric gases just prior to Mauna Loa activity may have been a premonitory sign. If so, this appears to afford an exceedingly valuable method of forecasting volcanic outbreaks. Furthermore, this incidence of hydrogen sulfide suggests a close relationship between solfataric activity and primary volcanism.

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SCIENTIFIC BOOKS

A GEOLOGICAL EXPEDITION TO THE SUNDA ISLANDS

Geological Expedition of the University of Amsterdam to the Lesser Sunda Islands in the Southeastern Part of the Netherlands East Indies, under the Leadership of H. A. Brouwer. Vol. 1, 348 pages, with numerous plates, maps and sections, 1940. Amsterdam (American sales agent, Nordeman Publishing Company, New York). Price, $8.40. Work to be completed in four volumes, by 1941; price for the set, $33.50.

THE able geologists and geophysicists of Holland have already shown that the vast East Indian Archipelago is supremely important for the genetic problems of continental stability, the origin of sea basins and the origin of mountain chains. Because it is a key region for investigations of terrestrial dynamics, the new data recorded in this four-volume symposium, due to the energy of Professor Brouwer, are particularly welcome. The present volume, on the geology and paleontology of the Netherlands half of the island of Timor, is written by D. Tappenbeck, A. L. Simons (both dealing with the general geology); by F. A. H. W. de Marez Oyens, another member of the 1937 expedition; and by Professor J. Wanner, of Bonn University. Oyens describes the Permian crinoids of Timor, and Wanner the Permian blastoids. Throughout, the emphasis is on the details of observation, in field and laboratory. The projected fourth volume "will coordinate the different contributions [including also those by seven other members of the expedition] and give the general conclusions which might arise."

The oldest system of Timor rocks, crystalline schists, were carefully studied; their age is pre-Triassic, but could not be more closely determined. Sedimentary series belonging to the Permian, Triassic, Jurassic, Cretaceous and Tertiary were found; unfortunately, their respective thicknesses are not given. An outstanding conclusion of Tappenbeck is that the Tertiary epoch of intense folding and thrusting should be placed in Oligocene time, rather than in the mid-Miocene, as so long believed by other investigators. Since Timor lies in the great "negative strip" of gravity anomalies, discovered by Vening Meinesz, this change of date for the major, orogenic disturbance of Tertiary time has significance for the general theory of mountain-making. The Simons chapter describes large masses of serpentine, especially voluminous along the north shore of the island; here is another proof that eruption of ultra-basic, igneous rock is an accompaniment of the intense deformation along the principal mountain arcs.

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THE INVERTEBRATES

The Invertebrates: Protozoa through Ctenophora. By LIBBIE H. HYMAN. First edition. 726 pp. McGraw-Hill Publications in the Zoological Sciences. A. Franklin Shull, consulting editor. 1940.

DR. HYMAN is to be congratulated on the appearance of the first volume of her courageous project to furnish a reasonably complete and modern account of the morphology, physiology, embryology and biology of the invertebrates. The real need of an accurate and critical survey of this sort in English has long been recognized alike by teachers, professional zoologists specializing in other fields and by advanced students. The author has achieved a satisfying measure of success in this important, confused and difficult field. "It is obviously impossible," Dr. Hyman says in her preface, "for any one person to have a comprehensive first-hand knowledge of the entire range of invertebrates, and consequently a work of this kind is essentially a compilation from the literature." It is obvious to the reader that the present work is not a mere rehashing of the literature but a fresh study of a

wealth of fascinating material. Dr. Hyman has had the interest and energy to engage herself in the Herculean task of dealing at first hand with many of the animals she is discussing. The majority of the profuse illustrations were made by the author directly from living and prepared specimens. For this purpose several summers were spent at various marine stations.

The original conception of the work was a three-volume treatise: one volume devoted to the non-coelomate invertebrates, a second volume for the coelomate forms, except arthropods, and a third volume for the arthropods. However, after six years of intensive work, it developed that the first volume would have to be split into two parts: (1) the lowest invertebrates through the radiate forms and (2) the acoelomate and pseudocoelomate bilateral animals. The present volume of 726 pages is part one. The book opens with two short introductory chapters, the first on protoplasm, the cell and the organism, and the second on classification. During the discussions of the fundamental nature of the developmental process and the nature of life there are challenging and provocative analyses of the chromosome-gene theory and the mechanistic theory. The chapter on classification summarizes previous taxonomic practices and briefly gives the author's reasons for her present scheme: 22 phyla based primarily on anatomical and embryological facts and on a number of important characters (not any one arbitrarily chosen feature) including general grade of construction, type of symmetry, presence and kinds of body space, absence or presence of an anus, presence of segmentation, possession of appendages, presence and nature of excretory, respiratory and endoskeletal systems. Dr. Hyman's procedure seems sound, conservative and workable. It should form a useful basis of discussion and further investigation. The Mesozoa and the Parazoa are separated from the Eumatozoa, which are divided into radiate and bilateral (in preference to diploblastic and triploblastic) grades. Among the Bilateria, three types of structure are recognized (following Schimkevitch), namely, the acoelomate, pseudocoelomate and eucoelomate types. "Such a division stands firmly on a realistic anatomical basis and eschews all theoretical vaporizings such as the alleged degradation of flatworms from annelids, the coelomic nature of the gonad cavities, and similar ideas." The Eucoelomata are subdivided into the Schizocoela and Enterocoela (Huxley). A suggestive phylogenetic tree (which readers are cautioned not to take too literally) derives the Bilateria from a primitive flatworm by way of a stereogastrula type of ancestor. Above the ancestral flatworms, the phyla are arranged in two main lines of ascent, the groups with determinate cleavage and mesoderm originating from definite cells or bands (Protostomia) and the groups with indeterminate cleavage and mesoderm and coelom arising as endodermal sacs (Deuterostomia).

The bulk of the book is devoted to detailed consideration of the Protozoa, the Mesozoa, the Porifera, the Cnidaria and the Ctenophora. The treatment of each group is introduced by a brief historical résumé. Then follow explanations of characters of the Phylum, classification, general morphology and physiology, discussion of the major divisions, phylogenetic and general considerations—including embryology, behavior, regeneration and ecological relations. Paleontology is given brief consideration. Each chapter is followed by an extensive and well-chosen bibliography, brought up to date. The author's approach, throughout, has been basically morphological. Not only gross structure but histological and cytological features are elucidated. The method of presentation is such that the text is to a large extent a discussion and elaboration of the illustrations. Specificity, clarity and economy are effectively achieved by this type of organization. The volume contains 221 figures, most of which occupy a full page and include a half dozen or more drawings, largely original. The rest are selected from the literature; many are redrawn. All are skilfully executed and well labeled. The "type" method has been avoided, since one of the major purposes of this treatise is to give an extensive account of the range of morphological variation to be found within each group. Frequently, original observations fill gaps in the literature and correct wide-spread misconceptions even about some of our common laboratory animals.

For the average zoologist, perhaps the greatest value of this book will be the opportunity of convenient access to the perplexing vocabulary of invertebrate morphology. Terms are explained clearly, often in relation to their homologues. In addition, the author has made an earnest effort to bring order out of confused terminology. As one example, such words as ectoderm, entoderm and stomodaeum have been limited to embryological stages. In their stead, the terms epidermis, gastrodermis and pharynx have been used for adult animals. One might be tempted to quibble with minor points such as the preferred definition of the cell or the concept of the acellularity of the Protozoa. Taxonomy can not fail to be controversial.

The technical execution of the book is admirable. There are surprisingly few typographical errors. The book is well indexed. It is earnestly hoped that the author will be able to complete the other volumes of the treatise, as visualized. Biology and the standard of biological teaching are certain to benefit by this capable revaluation of the invertebrates, in the light of recent progress, by an investigator of mature experience.

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REPORTS

SUMMARIZED PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE FROM 1934 TO 1940

THE Summarized Proceedings volume of the meetings of the American Association for the Advancement of Science and of the Pacific and Southwestern divisions for the years 1934–1939, inclusive, is now in the press and is expected to be ready for distribution in October.

From the founding of the association in 1848 until 1910, with the exception of 1861–65, Proceedings were published each year. Since 1910 Summarized Proceedings for several years each have been published in one volume as listed in Table 1:

TABLE 1

PERIOD	MEETINGS	PAGES
1911–1914	4	495
1915–1920	7	712
1921–1924	6[1]	979
1925–1928	6[1]	1,191
1929–1933	8[1]	1,245
1934–1939	21[2]	1,200

[1] Brief part-page reports of the meetings of the Pacific and Southwestern divisions were included.

[2] Includes twelve meetings of the association, one a joint meeting with the Pacific Division and one a joint meeting with both the Pacific Division and the Southwestern Division; four meetings of the Pacific Division and five meetings of the Southwestern Division, the summarized reports of which are almost as complete as are those of the meetings of the association.

Perhaps the best way to give a general idea of the contents of the forthcoming Summarized Proceedings is to quote its Preface, which is as follows:

PREFACE

The mere sight of a large book raises the question whether it is worth what it cost in labor and money. Is it just another ponderous addition to burdened library shelves? Will it serve any useful purpose? These questions will be asked about this volume; the answer to them should be based upon its contents.

In one respect this volume is unique. It contains the names of the more than 21,000 members of the Association arranged by states and towns, with the field of special interest of each one indicated. Since a very large percentage of the leading scientists of the United States and Canada are members of the Association, there is in this book a convenient answer to the often-arising question concerning what scientists in some special field live in a certain part of the country.

This volume contains also an alphabetical directory, which includes the names of all members of the Association, the degrees they have received, the academic or other positions they hold, their institutional or street addresses, their complete records as members of the Association, and the offices they have held in the Association.

This volume, however, does not consist primarily of lists of names. It contains a brief history of the Association since it was founded in 1848, and, consequently, of the development of American science, at least as far as it has been represented in the meetings of the Association. For clarity this history is divided into sections, each beyond the first being devoted to a decade. Each section includes a brief characterization of the science of the period, a list of the presidential addresses delivered in it, often with quotations of interesting passages, the titles of other papers of special interest, and, if they are published, the places of their publication. The constitution adopted in 1874 established vice-presidents for the sections who delivered retiring addresses, the titles and places of publication of which down to 1920 are included.

The section devoted to the period from 1921 to 1940 includes the titles and places of publication of the addresses of the presidents of the Pacific and Southwestern divisions from their organization. It includes also the titles and places of publication of all the Annual Sigma Xi addresses, of all Phi Beta Kappa addresses, of all Hector Maiben Memorial lectures and of all John Wesley Powell lectures, and, except in the few cases in which they are not known, the places of their publication.

Since this volume is especially a permanent summary record of the proceedings of the Association for the period from 1934 to 1940, the reports of its meetings for these years contain much more information than do those for earlier years. The titles listed include not only those of the addresses of presidents and vice-presidents but also all those that were open to the public as general sessions, with references to the places of their publication. The titles of more than two hundred and fifty addresses and papers are given. This volume also contains the titles of all the symposia presented at the twenty-one meetings of the Association and its divisions from 1934 to 1940, a total of more than two hundred at which nearly fourteen hundred papers were read.

In short, this volume contains sketches of the science of our predecessors and much of that which is recent. Those whose memories reach back a few decades will feel as they read of the youth of the Association a certain nostalgia for simpler days and attitudes that have passed. It is hoped that they will catch enough echoes from the historical part of this record to awaken in them many happy memories and only pleasant anticipations for the future. Those who are in the early parts of their scientific careers will be most interested in current progress in science. They may even be a little amused at what now seem naive ideas that were held in earlier days. Yet, it is hoped that for them the historical sections of this book will sometimes serve as a little mirror, like that in the front of a motor car, in which they may catch enough

glimpses of the road science has traversed to assist them in steering it wisely into the future.

There are many items of interest in the new Summarized Proceedings that are not mentioned in the Preface. For example, the registration and the numbers of papers presented at each meeting of the association since its founding are given, as well as the corresponding data for the Pacific and Southwestern divisions, except in a few cases in which the information is not available. For the first time the Summarized Proceedings contain in the report of each meeting, whether of the association or of one of the divisions, a complete list of the participating societies. Not only are they named, but also the number of papers on the program of each of them is given and all the symposia they organized or in which they participated. The number of papers in each symposium is given and the place of its publication, if published.

The advance sale of the new Proceedings has been so large, now about 4,200 copies, that it is not planned to print a number greatly in excess of those that have been sold. Since the printing will be from type that will be held for only a short time, instead of from plates, copies can be supplied only up to the number originally printed. The prepublication price to members of the association is $2.75 per copy, cloth-bound; after publication it will be $3.00. To those who are not members of the association it will be $4.00 per copy. The pages are 6 by 9 inches.

Table 2 gives comparative data for the preceding four volumes of the Summarized Proceedings and for the one now in press.

TABLE 2

PERIOD	COPIES PRINTED	UNIT PRICE	TOTAL RECEIPTS	TOTAL COST
1915–20	2,262	$1.00	$ 2,794	$ 5,430
1921–24	4,500	2.00	6,390	9,297
1925–28	4,250	3.50	11,060	11,060
1929–33	4,000	2.50	8,001	11,404
1934–39	4,500(?)	2.75	11,550	9,800(?)

The estimated cost for the volume in press includes printing, binding, cartons, mailing, postage, clerical help and circularization. The total deficit of the four Summarized Proceedings published from 1915 to 1933 inclusive was $8,886, or an average per issue of over $2,200. As a consequence of these deficits the office of the Permanent Secretary has been setting up reserves of about $1,000 per year to cover the prospective deficit on the present volume. Apparently the reserve may be held intact for the next volume.

F. R. MOULTON,
Permanent Secretary

SPECIAL ARTICLES

MORPHOLOGICAL AND FUNCTIONAL RECOVERY OF THE PANCREATIC ISLANDS IN DIABETIC CATS TREATED WITH INSULIN

PERMANENT diabetes has been produced in the normal dog by the injection for a few weeks of a crude saline extract of anterior pituitary glands.[1,2] Young[1] was not able to make normal cats permanently diabetic; nor were we in similar experiments. However, if one half to three fourths of the pancreas is removed, leaving enough to prevent spontaneous hyperglycemia and glycosuria, it is possible to make such cats permanently diabetic by a course of injections of anterior pituitary extract. Fifteen such animals have been prepared. The diabetes has persisted throughout the period of observation, which in some instances has been as long as five months after the last injection of anterior pituitary extract. Some of the permanently diabetic cats have been treated with insulin in an attempt to control the hyperglycemia. In five of these animals insulin was stopped after varying periods of freedom from glycosuria and hyperglycemia. In these five animals (see Table I) the withdrawal of insulin was not followed by a return of glycosuria, and the blood glucose was within normal

TABLE I

DIABETIC CATS RECOVERING AFTER INSULIN TREATMENT

Cat No.	Glycosuria: During injection of ant. pit. extract	Glycosuria: Interval between ant. pit. extract and insulin	Severity of diabetes*	Duration of insulin therapy	Duration of recovery†
	days	days	per cent.	days	days
R– 3	43	29	60	24	105
R– 5	18	15	64	27	56
R–10	25	56	43	20	100
R–12	10	12	63	32	113
R–21	13	6	66	9	36

* Expressed as the percentage of the calculated available glucose of the diet (21.6 gm/day) excreted in the urine for 6 days prior to insulin therapy. For R–21 the previous 2 days were used.

† Non-diabetic period from cessation of insulin therapy to end of experiment.

[1] F. G. Young, *Biochem. Jour.*, 32: 513, 1938.

[2] F. C. Dohan and F. D. W. Lukens, *Am. Jour. Physiol.*, 125: 188, 1939.

limits before and after feeding. The diet, with one minor exception, was constant. The daily rations consisted of 200 grams of beef heart supplemented with cod-liver oil, yeast and bone ash. This recovery from the previous diabetic state has been maintained to the termination of the experiment, a period of more than three months in several of the animals. The cats continued to gain weight throughout this period.

Biopsy specimens of the pancreas of permanently diabetic cats taken *before* treatment with insulin show marked hydropic degeneration of the islands of Langerhans. In cats exhibiting functional recovery *following* insulin therapy the islands are histologically normal. Some animals did not show "permanent" recovery with insulin treatment. These instances were associated with infections, poor control of the diabetes by insulin or institution of insulin treatment after more than five months of diabetes.

In dogs made diabetic by removal of about nine tenths of the pancreas hydropic degeneration of the islands is present for the first few months.[3] Using such dogs, Copp and Barclay[4] have observed morphological restoration of the islands *during* periods of insulin therapy. Despite the morphological improvement it was necessary to continue the administration of insulin. Since the diabetes had been produced by partial pancreatectomy alone, it was not to be expected that morphological restoration of the remaining islands would maintain functional recovery. We have failed to obtain morphological (or functional) recovery in dogs made permanently diabetic with anterior pituitary extract. This we attribute to the early development of atrophy of the islands of Langerhans in our dogs, in contrast to the hydropic degeneration found in the experiments of Copp and Barclay and in our cats. However, it has recently been demonstrated in dogs that the concurrent administration of insulin may hinder the fall in the insulin content of the pancreas and the hydropic degeneration of the islands which occurs during the period of injection of certain anterior pituitary extracts.[5]

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THE NEURO-MOTOR MECHANISM OF THE SMALL BLOOD VESSELS OF THE FROG

THE mechanism which regulates capillary blood flow has not been definitely established. In Krogh's laboratory, Vimtrup[1] reported the contraction of Rouget cells in Amphibia, which caused folding of the endothelium. Field,[2] using the frog and rat, and also Beecher,[3] using the rabbit's ear, confirmed Vimtrup and in addition observed the swelling of endothelial nuclei which blocked the lumen of the capillary. The Clarks[4] reported endothelium to be contractile in the tadpole's tail but not in the rabbit's ear. They deny the contractility of extra-endothelial cells (Rouget cells) in mammals and amphibians, with the possible exception of the nictitating and hyaloid membranes of the frog. Zweifach[5, 6] reported endothelial contractility in the frog and mouse. In response to mechanical stimulation, contraction of the endothelium in the frog "completely closed the lumen of the vessel only at its ends." At the "capillary exit in those regions where the capillary offshoot leaves the arteriole," he observed valve-like folds of endothelium which opened and closed passively with dilatation and constriction of the arteriole. In the mammal Zweifach[7] comes to the conclusion that the contractility of capillary endothelium has little physiological significance.

We have examined, by means of stimulation with a micro-electrode, the distribution of the contractile elements of the small blood vessels in the retrolingual membrane of the frog. In contrast to the uniform layer of the typical smooth muscle of the arteriole, and the somewhat scattered arrangement on the precapillary, the modified smooth muscle cells of the capillary are confined to the region of its origin. If the capillary branches before emptying into a venule, the branches are devoid of smooth muscle cells and do not contract. The region of the capillary origin may act as a unit with its adjacent blood vessels, but frequently it acts independently of them as a sphincter-like mechanism. This concept of the control of capillary blood flow is supported by the evidence presented below.

In the frog with brain and medulla pithed, the retrolingual membrane was prepared for illumination by transmitted light, after the method of Pratt and Reid.[8] A micro-electrode, 1–5 micra, was placed in the field by an Emerson micromanipulator. Cinephotomicrographs were obtained, using a light-splitting prism.

Brief faradic stimulation of the small vasomotor nerves produced dilatation of the small blood vessels, followed by constriction. Weak stimulation usually

[1] Bj. Vimtrup, *Zeitsch. f. d. ges. Anat.*, 65: 150–182, 1922.
[2] M. E. Field, *Skand. Arch. f. Physiol.*, 72: 175–191, 1935.
[3] H. K. Beecher, *Skand. Arch. f. Physiol.*, 73: 1–6, 1936.
[4] E. R. Clark and E. L. Clark, *Am. Jour. Anat.*, 66: 1–49, 1940.
[5] B. W. Zweifach, *Anat. Rec.*, 59: 83–108, 1934.
[6] B. W. Zweifach, *Anat. Rec.*, 73: 475–495, 1939.
[7] B. W. Zweifach, *Am. Jour. Physiol.*, 120: 23–35, 1937.
[8] F. H. Pratt and M. A. Reid, SCIENCE, 72: 431–433, 1930.

[3] F. M. Allen, *Jour. Metab. Res.*, 1: 5, 1922.
[4] E. F. F. Copp and A. J. Barclay, *Jour. Metab. Res.*, 4: 445, 1923.
[5] J. Campbell, R. E. Haist, A. W. Ham and C. H. Best, *Am. Jour. Physiol.*, 129: P328, 1940 .

produced only dilatation. Strong stimulation of the same nerve frequently produced only constriction. These results suggest that the nerves stimulated contained vasodilator and vasoconstrictor fibers, and that the vasodilators possessed a lower threshold. Furthermore, the area constricted was frequently only a portion of that originally dilated. As additional evidence of dual innervation, vasomotor nerves were found which produced only one type of response to all strengths of stimulation. Although our histological preparations show an anatomically continuous loosely-meshed non-myelinated nerve plexus continuous with the perivascular plexus, it is conceivable that dilator and constrictor fibers might occasionally become segregated.

Faradic stimulation of small nerves produced responses confined to limited vascular areas. Therefore, although the nerve plexus appears to be anatomically continuous, functional innervation is discontinuous. Stimulation of any one of several small nerves in the field produced a response in the same limited area. This fact suggests the concept of a smooth muscle motor-unit. Limited vascular areas were seen to beat rhythmically at times. No central reflex could be involved, and we have found no ganglion cells in the membrane.

Faradic stimulation of small nerves produced dilatation and contraction of the capillary only in the region of its origin. This region may respond independently of the supplying arteriole or precapillary, and function as a sphincter. Such sphincter-like regions sometimes show spontaneous rhythmic contractions, quite independent of the supplying vessel. Nuclei of contractile pericapillary cells were always seen in this region. In preparations vitally stained with methylene blue the capillary origins possessed a few modified smooth muscle cells with branched cytoplasmic processes. They are probably the type of cell originally described by Rouget,[9] redescribed by Vimtrup[10] in Amphibia, and reported by Field[11] in the rat. Furthermore, the perivascular nerve plexus was rich on the arterioles and precapillaries but sparse on the capillaries. Various pericapillary cells were found farther along the capillary. Except for an occasional cell, these did not respond to electrical stimulation. Further experiments are in progress, with drugs and with denervated preparations, to determine the nature of the independent activity and the rhythmic responses.

Both direct observation with a water immersion lens and careful study of the cinephotomicrographs of the active capillary origins failed to disclose the swelling of endothelial nuclei into the lumen, or the presence of endothelial valves. Endothelial contraction in response to stimulation of the nerves or to direct electrical and mechanical stimulation did not occur. It appears, therefore, that in the retrolingual membrane of the frog, the capillary origins are provided with modified smooth muscle cells and thus regulate capillary blood flow in a sphincter-like manner without the aid of the supplying vessel.

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[9] C. Rouget, *Arch. de Physiol. Norm. et Path.*, 5: 603–663, 1873.
[10] *Loc. cit.*
[11] *Loc. cit.*

EGG-WHITE INJURY IN CHICKS AND ITS RELATIONSHIP TO A DEFICIENCY OF VITAMIN H (BIOTIN)

THE action of Vitamin H in protecting against the injury caused by a diet containing egg white is somewhat unique in that the diet can not be considered to be deficient in an essential food constituent. Omission of the egg white from the injury-producing diet gives a ration which apparently does not lack any of the needed vitamins. This appears to be in contrast to the action of the various members of the vitamin B group in curing or preventing nutritional injuries, for the diets in these cases have always been found to be definitely deficient in the vitamin in question.

The recent observations of György, Melville, Burk and du Vigneaud have shown that vitamin H is probably identical with biotin (and co-enzyme R).[1, 2] In view of their results, it appeared that a study of the biotin intake and excretion and the biotin content in the tissues of chicks receiving egg-white injury diets might be helpful in throwing some light on the manner in which vitamin H functions.

Day-old chicks were placed on the following diet: yellow corn, 55 per cent.; wheat middlings, 20 per cent.; purified casein, 20 per cent.; bone meal, 1.5 per cent.; limestone, 2 per cent.; cod liver oil, 1 per cent.; and iodized salt, 0.5 per cent. When ten days old, the chicks were divided into two groups. One, the controls, was continued on this same diet, and the other group was given a ration in which the purified casein was replaced by dried egg white. Samples of the two diets, digested in 20 per cent. sulfuric acid for 18 hours at 100° C., gave the following assay values for biotin by the method of Snell, Eakin and Williams[3]: control diet, 0.39γ per gram; injury diet, 0.67γ per gram. Twenty-four-hour samples of the feces from the two groups were collected at intervals throughout a month, dried, weighed and carefully sampled. Aliquots were tested, both for free (extractable) biotin,

[1] Paul György, Donald B. Melville, Dean Burk and Vincent du Vigneaud, SCIENCE, 91: 243, 1940.
[2] Since this investigation was started, private information from Dr. du Vigneaud to one of us confirms the identity of vitamin H and biotin.
[3] E. E. Snell, Robert E. Eakin and Roger J. Williams, *Jour. Am. Chem. Soc.*, 62: 175, 1940.

and for "bound" biotin, *i.e.*, biotin which was liberated after 18 hours digestion of the feces at 100° C. in 20 per cent. sulfuric acid. Although there were some irregularities in the assays, it was found that both groups of chicks were excreting from 10 to 20 per cent. of their biotin intake as free biotin and approximately 15 to 25 per cent. additional as "bound" biotin. On an actual weight basis, the injured chicks were, of course, excreting more than the controls, since their intake was greater.

By the eighth week, the usual syndrome had become very pronounced in the injured group, so the tissues of two chicks from each group were then assayed for their biotin content; two weeks later tissues from an additional chick of each group were tested. These tissues were allowed to autolyze under toluene for three days at 37° C., after which they were thoroughly extracted with hot water. The tissues from the injured chicks were found to be consistently lower in their biotin content than were those from the control chicks, as can be seen from the tabulation of the assay values (Table 1).

TABLE 1

BIOTIN CONTENT OF TISSUES IN γ PER GRAM

Diet: Age:	Injury 8 wks.	Injury 8 wks.	Injury 10 wks.	Control 8 wks.	Control 8 wks.	Control 10 wks.
Blood	0.0018	0.0021		0.0051	0.0067	0.0042
Liver	0.95	0.58	0.60	2.5	2.8	2.6
Kidney	0.45	1.3	1.0	1.9	1.8	2.5
Heart	0.018	0.041	0.036	0.11	0.033	0.11
Brain	0.025	0.029	0.044	0.067	0.018	0.065
Leg muscle.	0.008	0.016	0.015	0.027	0.018	0.033

These preliminary results indicate that the biotin which is present in the diet of the injured chicks (and which is more than sufficient in the absence of egg white) is not available to the tissues. Presumably it is destroyed by interaction with the egg white, and therefore an excess of biotin must be present in a diet containing egg white in order for the tissues to receive the necessary amount. It is probable that the injury caused by egg white is not due to any direct toxin, but rather is produced indirectly by the action of the egg white in making the biotin of the diet unavailable. If such is the case, it should be possible to produce similar syndrome by a diet which is actually deficient in biotin, but which contains no egg white.

We wish to thank Dr. T. H. Jukes for his kind cooperation in furnishing advice and certain materials for these experiments.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

MOLECULAR WEIGHT BY ISOTHERMIC DISTILLATION

OF all the solution methods for the determination of molecular weight of organic substances, the ingenious method of G. Barger[1] offers the widest applicability. This method is based upon the fact that a solution of higher molarity takes up solvent from a solution of lower molarity and *vice versa* until an equilibrium is reached. In a closed system, this produces changes in the volumes of a given standard solution of known molarity and the solution of the unknown substance but of known concentration. In practice, these changes in volume are determined by measuring at certain time intervals the diameter of several droplets contained in a sealed capillary and containing alternately the standard solution (*st*) and the solution of the unknown (*s*) in the same solvent which need not be pure (ethyl alcohol, pyridine, etc.). By appropriately choosing the molarity of the standard until the least changes are noted, the molecular weight of the unknown, the concentration of which, however, is known, may be readily calculated

$$\left(\frac{\%\ s}{M\ st} \times 10\right).$$

[1] G. Barger, *Jour. Chem. Soc.*, 85: 286, 1904; *Ber.*, 37: 1754, 1904.

The greatest drawback of this method as well as its various modifications[2] is that the droplets, either in the filling operation or subsequently on standing, frequently undergo mixing, thus invalidating the determination.

It has now been found that this objection, namely—the mixing—is readily overcome by having the two solutions, the standard and the unknown, in two separate capillaries of about 7–8 cm in length and 1–1.5 mm in diameter (Fig. 1, A and B). The capillaries

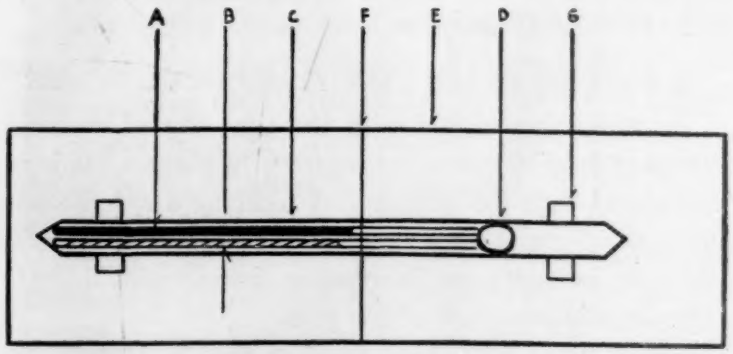

FIG. 1. Apparatus for isothermic distillation.

are filled by drawing up by suction the respective solutions, while they are open at both ends. Then the

[2] J. B. Niederl and V. Niederl, "Micromethods of Quantitative Organic Elementary Analysis," pp. 184–186. New York, N. Y.: J. Wiley and Sons. 1938.

capillary orifice furthest away from the solution is sealed in a micro burner. After cooling, the solution is centrifuged towards this sealed end. The two capillaries thus filled are then placed in a suitable glass tubing about 10 cm in length and 5 mm in diameter (C). They are put in place by means of a wad of glass wool or cotton (D). The tube is then evacuated to about 15 mm pressure and is then sealed by means of an ordinary Bunsen burner. The tube may once more be subjected to centrifuging in order to have a clean-cut meniscus of each of the solutions contained in the capillaries. By means of adhesive tape (G) the tube is then attached to a rectangular glass plate, which is about 12 cm long and about 4 cm wide (E) and which possesses a hairline or a scratch across its width (F). The plate thus mounted is then placed into a water bath which is kept at room temperature to within $\pm 3°$ C. After four days, the distance between the two meniscii of the two solutions and the scratch, or hairline on the plate, is measured under a low-powered microscope possessing a micrometer scale in the eyepiece. These measurements are repeated subsequently once a day for a week. Thus it is easily ascertained which of the two solutions lost less solvent, this being the solution of higher molarity.

The molarities of the standard (azobenzene) employed are 0.05, 0.1 and 0.15 and the most suitable concentrations of the unknown sample are between 1 and 3 per cent. Differentiation between ± 0.01 molarities is possible.

The method described precludes any possibility of mixing of the two solutions and also permits the recovery and re-use of the unknown, while the results,[3] which will be published in detail in an appropriate analytical journal, compare favorably with the original Barger method or any of the known modifications thereof. The weighing out of the sample may be done on a macro, semi-micro or micro scale.

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A SIMPLE STAIN FOR TISSUE CULTURES

ANY one confronted with the necessity of staining hanging-drop tissue cultures grown in plasma has been impressed with the difficulty of securing a cytoplasmic stain which would not also tint the plasma of the clot to such intensity as to obscure largely the delicate cytoplasmic contours of the cells.

Many stains have been tried in this laboratory for coloring tissue cultures *in situ* in the plasma clot. The following simple method has given consistently good results on countless cultures over a period of nearly a year. It was developed to stain particularly cultures of brain tissue in which it reveals with a surprising clarity the finest processes of the cells as well as the nuclei and certain cytoplasmic inclusions.

[3] A. M. Levy, M.Sc. Thesis, New York University, Graduate School, April, 1940.

METHOD

(1) Remove all paraffin and vaseline from the coverslip with cotton pledgets soaked in chloroform.

(2) Fix in 10 per cent. neutral formalin or absolute alcohol for 24 hours.

(3) Place in 1 per cent. aqueous solution of Toluidine blue for 1 hour.

(4) Wash in two changes of distilled water.

(5) Dehydrate in 85 per cent. alcohol 2–3 minutes.

(6) Place in 95 per cent. alcohol 2–3 minutes.

(7) Transfer to absolute alcohol until the clot contains little stain. This step may be controlled by watching the decoloration under a microscope. The differentiation takes 5–10 minutes.

(8) Clear in xylol.

(9) Mount in balsam or Nevillite.

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BOOKS RECEIVED

BARKER, LEWELLYS F. *Psychotherapy.* Pp. ix + 218. Appleton-Century. $2.00.

Carnegie Institution of Washington. *Miscellaneous Papers, XIV–XXI; Botany of the Maya Area.* Pp. 474. Illustrated. The Institution.

CARROLL, PAUL L. and WILFRED F. HORNER. *An Atlas of the Frog.* Looseleaf. Illustrated. Mosby. $1.25.

DEAM, CHARLES C. *Flora of Indiana.* Pp. 1236. Illustrated. Department of Conservation, Division of Forestry, Indiana. $3.50.

GALDSTON, IAGO. *Progress in Medicine.* Pp. 347 + xiv. Knopf. $3.00.

GERARD, R. W. *Unresting Cells.* Pp. xv + 439. 173 figures. Harper. $3.75.

HUME, EDWARD H. *The Chinese Way in Medicine.* Pp. 189. Illustrated. Johns Hopkins Press. $2.25.

LEACH, JULIAN G. *Insect Transmission of Plant Diseases.* Pp. xviii + 615. 238 figures. McGraw-Hill. $6.00.

PRODINGER, WILHELM. *Organic Reagents Used in Quantitative Inorganic Analysis.* Translated from the second German edition by STEWART HOLMES. Pp. xiv + 203. Nordemann. $5.00.

SCHILLETTER, JULIAN C. and HARRY W. RICHEY. *Textbook of General Horticulture.* Pp. ix + 367. 136 figures. McGraw-Hill. $3.00.

SWIGERT, ARTHUR M. *The Story of Superfinish.* Pp. 672. 720 figures. Lynn, Detroit.

The Changing Front of Health. Proceedings of the Eighteenth Annual Conference of the Milbank Memorial Fund, April, 1940. Pp. 104. The Fund, New York.

University Mathematical Texts: AITKEN, A. C. *Determinants and Matrices.* Pp. 135. *Statistical Mathematics.* Pp. 153; GILLESPIE, R. P. *Integration.* Pp. 126; INCE, E. L. *Integration of Ordinary Differential Equations.* Pp. 148; RUTHERFORD, D. E. *Vector Methods.* Pp. 127; TURNBULL, H. W. *Theory of Equations.* Pp. 152. Interscience Publishers, New York. $1.50 each.

VIGOUREUX, P. *Quartz Oscillators and Their Applications.* Pp. vi + 131. 86 figures. His Majesty's Stationery Office, London. $1.35.

WERKMEISTER, WILLIAM H. *A Philosophy of Science.* Pp. xii + 551. 29 figures. Harper. $4.00.